Forest Service Citizen Science Project Planning Guide

Special Thanks

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Special Acknowledgements: *Leslie Weldon, Deputy Chief for National Forest System; Jamie Barbour, Assistant Director for Adaptive Management; Rick Ullrich Assistant Director for Resource Information Group.*

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INTRODUCTION

Citizen science brings together two important Forest Service values – using sound science to guide our decision making and connecting our work to the public we serve. The Agency has a long history of engaging volunteers in the scientific process on a wide variety of citizen science projects, including studies of wildlife, cultural resources, watershed health, and silviculture. Citizen science offers a great opportunity to work side-by-side with our communities to increase education and interest in the fields of science, technology, engineering and math, and to encourage the next generation of environmental stewards. Volunteers of all ages and skill levels help fulfill our mission by collecting data we couldn't collect on our own and by bringing new, innovative ideas to resource management.

Efforts to institutionalize citizen science within the government has led to the creation of a Federal Citizen Science Toolkit meant to provide resources and guidance applicable to all agencies. To provide information specific to the Forest Service, the Forest Service Citizen Science Toolkit was created. This guide references the 2017 Crowdsourcing and Citizen Act and builds upon other citizen science toolkits such as the Cornell Lab of Ornithology Citizen Science Toolkit.

Defining citizen science

The term citizen science[1] means a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process in various ways, including:

- formulating research questions
- creating and refining project design
- conducting scientific experiments
- collecting and analyzing data
- interpreting the data results
- developing technologies and applications
- making discoveries
- solving problems

If you wish to learn about terms related to citizen science, legal considerations, and the policy supporting citizen science, visit the Forest Service Citizen Science homepage and click on the drop-down menus under "FAQ" and "Additional Resources".

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[1] Definition is from the 2017 Citizen Science Act. Sec. 402 of the American Innovation and Competitiveness Act. https://www.congress.gov/bill/114th-congress/senate-bill/3084/text

CHAPTER 1

Determine if citizen science is right for your project

Despite its many benefits, citizen science is not appropriate for all projects and information needs, and conventional science or other methods of public engagement may be better suited to some situations.[2] Before making a project plan, consider if citizen science is the best approach for your objectives.

When citizen science is advantageous

Citizen science may be advantageous to your project when...

The training required is not highly technical

For volunteers to collect high-quality data, sometimes projects that require minimal training are the best approach. For example, collecting insects and making simple measurements, such as tree circumference, are easy to do without extensive instruction or instrumentation. Volunteers can also collect data that require following elaborate protocols or developing specialized skills, such as in many water quality monitoring programs, provided that they are given proper training. In some cases, your project may only be appropriate for retired or current technical professionals that have a higher aptitude for complex protocols.

Public participation in the scientific process serves your organization's goals

Citizen science is advantageous when it fits your organization's goals for public input and engagement and helps in decision-making through the generation of both scientific knowledge and learning. Public input can help identify the most relevant questions and best methods to carry out a study, particularly if the research is focused on an issue that involves local people. For example, local or traditional knowledge, such as harvesting or hunting practices, can help scientists understand human behaviors, local ecology, and impacts to species, enabling them to formulate research questions and methods that can best help managers and other decision makers.

You want to promote STEM learning

Citizen science is a great opportunity to provide students an immersive experience in Science, Technology, Engineering and Math (STEM). When volunteers are involved in the various aspects of a project including the development of the problem or question, data collection methods and data analysis, participants are introduced to the entire scientific process. Volunteers will also be attuned to data quality issues or concerns. When participants are able to share the results of their work, they can gain a deeper understanding of the importance of the science and how it supports decision making and resource management.

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[2] Snall et al., 2011; McDonough-MacKenzie et al., 2016

You need data across a large spatial area or for a long period of time

Citizen science can often operate at greater geographic scales and over longer periods of time than conventional science. Only with the help of volunteers would it be cost-effective to collect certain types of data in large enough areas and over long enough periods of time to be scientifically reliable. This is often the case in observations of breeding birds and in other physical and biological phenomena.[3] The North American Breeding Bird Survey, for example, has relied on volunteers to track the abundance of bird populations across the continent.[4] Other projects, such as Nature's Notebook, encourage volunteers and professional scientists to regularly submit observations of plant and animal occurrences, behaviors, and seasonal events such as tree flowering.[5] Hundreds of air and water quality monitoring programs across the country depend largely on data and samples collected by citizen science volunteers.[6] The resulting observations are used by professional scientists, government agencies, non-governmental organizations, and other decision-makers.[7]

You need many eyes on the ground

Citizen science can speed up and improve field detection.[8] Having many eyes on the ground can help detect environmental changes (e.g., population declines, incidences of pollution, and the introduction of an invasive species)[9]; as well as monitor the effectiveness of management practices;[10] and increase the likelihood of a serendipitous discovery. It can also help if your project site is in a place people frequently visit.

You must analyze a large amount of data or images

When large amounts of data need to be analyzed, volunteers can speed up the process. Volunteers with proper training and guidance can accurately identify specimens at various taxonomic levels and accurately assess important population attributes, such as species abundance and distribution.[11] Volunteers can also perform tasks difficult for computers, like analyzing digitally-collected primary data (e.g., images or audio), and by identifying and recording secondary information (e.g., presence or absence of a species and the abundance, behavior, and frequency or duration of various phenomena).[12] In some cases, highly trained volunteers such as retired professionals may be able to contribute to higher-level data analysis.

The tasks involved can be completed online

Similarly, projects that involve sorting and analyzing large amounts of online data (for example, satellite images or photos from web cams) are often suitable for a crowdsourcing approach.

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[3] Bhattacharjee, 2005; Devictor et al., 2010; Zapponi et al., 2016; Edgar et al., 2016

[4] Rodriguez, 2002; Sauer et al., 2003

[5] Fuccillo et al., 2015

[6] Stepenuck and Green, 2015

[7] Stepenuck and Green, 2015

[8] Liebenberg et al., 2016).

[9] Hemmi and Graham, 2014; Ingwell and Preisser, 2011; McCormick, 2012; Barnard et al., 2016

[10] Conrad and Hilchey, 2011

[11] Crall et al., 2011; Danielsen et al., 2014

[12] Ellwood et al., 2015

You could benefit from traditional knowledge

Citizen science can help refine research questions and interpretation of results. Participants in citizen science are affected by and observe local natural resources and the environment in their daily lives, so they can help improve the relevancy of location-specific research questions and make them more useful to managers and local communities.[13] For example, people in Washington state harvest salal, a culturally and economically important forest shrub used in floral arrangements and is also important for wildlife habitat.[14] Concerned about the decline of salal, scientists worked with people who harvest the shrub to formulate research questions about the sustainable use of the plant. The results of the study using those questions helped everyone involved understand why salal might decline and how to harvest it without diminishing the resource. Volunteers can use local or traditional knowledge to help professional scientists interpret results, particularly in explaining unusual data and in research projects that explore how people interact with ecological processes.[15] A full understanding of natural resource and environmental issues often requires a holistic perspective, which citizen science can provide.

You are studying the social dimensions of natural resource management

Citizen science can help researchers better identify and study connections between humans and their environment. Citizen science is well suited for interdisciplinary collaboration, particularly for projects that include both natural and social angles. Conservation scientists and natural resource and environmental managers increasingly address the social aspects of difficult ecological issues, such as managing wildfires in the wildland-urban interface and conserving nature in human-dominated landscapes.[16] By engaging local community members, citizen science can facilitate an understanding among managers, scientists, regulators, decision-makers, volunteers, and others of the social dimensions of the natural systems where people live.[17]

When citizen science is *not* advantageous

Citizen science may *not* be advantageous to your project when…

The training or equipment are highly technical

Volunteers should not be expected to use sophisticated analytical instruments or participate in activities that require extensive training or certification. It would be unrealistic to ask volunteers to take measurements using equipment that is expensive or difficult to obtain, or to complete tasks that are complicated or require immense time commitments. For example, a volunteer would likely not be able to take highly detailed measurements every four hours for a long period of time.

Instead, you might consider what simple tasks volunteers can do that would give trained resource specialists more time to do highly technical tasks. For example, the Four Forests Restoration Initiative works with citizen scientists to

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[13] Ballard et al., 2008; McKinley et al., 2012

[14] Ballard and Huntsinger, 2006

[15] Ballard and Huntsinger, 2006; Haberl et al., 2006; Huntington, 2000; Laidler, 2006

[16] Cooper et al., 2007; McKinley et al., 2012; Winter et al., 2002

[17] Cooper et al., 2007; McKinley et al., 2012

collect simple presence-absence data on hydrologic features, allowing the Forest resource specialists more time to do more complex surveys.

Also, infrequent (e.g., annual) sampling might make it harder to sustain a collection of high-quality data, because participants might have to re-learn even basic protocols. A successful sampling design for volunteers lies in between, where sampling frequency is just enough to keep participants well practiced and able to gather consistent data, but not so high as to become onerous and discourage participation.[18]

Other ways to engage the public are more suited to your goals

Citizen science is one of many ways to engage the public in decision-making processes and environmental stewardship. Depending on your project, those other avenues may be a better fit for your outreach goals. Sometimes direct public outreach is more effective than citizen science projects,[19] particularly when the connection between the science collected and management or policy decisions is not obvious. If scientific knowledge is already adequate, then additional data collected through citizen science is not needed, and resources may be better spent focusing on how to improve the communication of existing knowledge through newsletters, science cafés, public meetings, online, or through other creative sources.

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[18] Theobald et al., 2015
[19] Lane et al., 2007

CHAPTER 2

Start with the basics

If you have decided that citizen science is the best fit for your project, you're probably eager to get it started. Let's first address the basics; what are your project objectives? Are there preexisting projects or protocols? How will your project be funded?

Objectives

Before starting your project, articulate what outcomes you wish to accomplish.

- What do you want to study and what is the problem or question you are trying to resolve?
- Do you want to reach a certain number of volunteers? Promote student learning? Outreach to a unique group?
- What data will you collect? How will collecting this data help achieve your project goals? What is the appropriate grade of data quality needed for your project?
- How will you display your results to clearly show the connection with your objectives?

Thinking through your objectives helps you achieve them in a targeted manner, which paves the way for better results.

Timeline

Determine if you need information monthly, seasonally, or annually. For example, you might need a lot of baseline data the first few years and then can cut back and rotate through sites/districts annually.

Preexisting projects

Perhaps there is already a similar citizen science project that answers your question. There is no need to reinvent the wheel when there are projects out there that have been tested and improved over many years. Here are resources to help you find other citizen science projects.

Federal Citizen Science and Crowdsourcing Catalog
The Federal Citizen Science and Crowdsourcing Catalog tracks citizen science projects involving federal government agencies. If you only wish to see Forest Service projects, click the "Agency Sponsor" dropdown menu and check "U.S. Forest Service (USFS)".

The Cornell Laboratory of Ornithology – Citizen Science Central

The [Cornell Laboratory of Ornithology - Citizen Science Central](#) also tracks citizen science projects. This includes citizen projects about birds but also mammals, invasive species, air quality, water quality, weather and other categories.

SciStarter

The website [scistarter.com](#) features a searchable list of citizen science projects.

CitSci.org

[CitSci.org](#) allows viewers to search their list of active citizen science projects.

Preexisting protocols

There may already be protocols that meet your needs or can be easily modified to do so. Listed below are resources to help you find some pre-existing protocols.

FS Monitoring Protocols

The [Forest Service Monitoring Protocols](#) page lists all agency-wide monitoring protocols, some of which can be adapted to meet your needs.

NEMI

The [National Environmental Methods Index](#) (NEMI) is a searchable database that allows scientists and managers to find and compare analytical and field methods for all phases of environmental monitoring.

GLOBE

NASA's [Global Learning and Observations to Benefit the Environment (GLOBE) Program](#) offers curriculum and citizen science protocols for teachers and citizen scientists about earth science topics, including the atmosphere, biosphere, hydrosphere and soils.

Funds

As with any project, the budget should be clearly laid out in the project plan. This of course includes roles and responsibilities – who does what, when, and at what cost? Partner organizations ([Chapter 3](#)) can be key in providing goods and services through direct investment, in-kind contributions, or applying to external grants for additional funding not otherwise available to the Forest Service.

- [Forest Service Citizen Science Competitive Funding Program](#) is a new opportunity to compete for up to $25,000 in funding for your collaborative project that meets a defined USFS information need.

- [Grants.gov](#) is an E-Government initiative operating under the governance of the Office of Management and Budget which provides a centralized location for grant seekers to find and apply for federal funding

opportunities. Today, the Grants.gov system houses information on over 1,000 grant programs and vets grant applications for [federal grant-making agencies](#).

- [Federal and Private Grant Funding Resources](#) for both federal and private grants. Includes specific resources and information for projects and programs including: recreation, forest health, watershed restoration, fire, conservation education, wildlife, plants, communities, etc.
- [Partnership Grant Calendar](#) is a site managed by Mt. Baker-Snoqualmie National Forest that lists federal & private grant deadlines.
- [Start a Partnership With the Forest Service or Obtain Federal Financial Assistance: A Guide for Tribal Governments](#)
- The [Matching Awards Program](#) is a competitive grant program which funds implementation of on-the-ground conservation and restoration projects that have an immediate, quantifiable impact on the National Forest System. There are two award cycles and requirements for matching funds.
- To learn more about [Crowd Funding](#), check out this 1-page document that provides an overview.

CHAPTER 3

Build your team

Now, let's figure out the appropriate personnel and partners involved in your project and the forms and agreements relevant to those groups.

Personnel

To successfully launch a citizen science project, you may need help from a variety of personnel. Not all of them may be necessary depending on the design of your project.

Staff positions

- **Program Manager/Lead Scientist** – Every project will need at least one person who develops and runs the program. It is recommended to have two staff members in order for the program to be resilient and sustainable during times of turnover, extended staff time off, and other possible delays in the project. A lead scientist would have expertise about the species or program needs.
- **Partnership Coordinator** – This position coordinates with partners and the project head and has the most current information on how to develop partnerships.
- **Volunteer Coordinator** – A key position for large or lengthy projects is a Volunteer Coordinator, who recruits and communicates with volunteers, manages their schedules and training, updates volunteer resources and information to the website, and recommends volunteers for awards or other recognitions. This could be a staff member from the Forest Service or a partner organization. Coordinators and others should utilize the "Volunteers in the Forest Service: A Guide for Coordinators" as additional guidance for program administration.
- **GIS Specialist** – If you are considering developing a custom app or using ArcGIS Online, a GIS Specialist may be able to advise you. Your local GIS specialist can teach you how to collect spatial data in a way that meshes with existing Forest Service data and databases.
- **Data Manager** – A data manager may be necessary to enter and upload data into a usable format.
- **Resource Specialist** – This person is an expert in the subject area. They identify the questions most useful to the Forest Service and the information your volunteers will collect. They also play a role in analyzing and using the data collected.
- **Team Leaders** – A Team Leader instructs and accompanies volunteers on the field. For example, in citizen science projects involving youth, local science teachers often lead and assist students in collecting data. A team leader could also be a staff member from the Forest Service or a partner organization.
- **Grants & Agreements Specialist** – The G&A specialist best understands which partnership tools and methods will contribute to a successful project. They can advise on negotiating the terms of contracts, agreements, and grants and is the expert in policy requirements.
- **Public Affairs Officer** – This person gets the word out about a citizen science project both for enlisting engaged and enthusiastic volunteers as well as promoting the results of a successful project. They could be

a staff member from the Forest Service or a partner organization, well-versed in the talking points of the project and sensitive to potential misinterpretations of issues covered in the research.

- **Line Officer and Leadership** – Ensure project success by providing the needed time and resources to the project leads and relevant staff that support the project.

Internships & student programs

You might consider hiring a temporary employee to fill in some of the roles above. The Forest Service has several internship programs to bring in new employees, listed below. Note: since they are being financially compensated for their time, these employees would not be considered citizen scientists.

- **Resource Assistant Program** – Resource Assistants are employed by partner organizations, but work on Forest Service units or projects under the supervision of agency staff. Types of work include monitoring species and conducting research, coordinating volunteers and leading Youth Conservation Corps (YCC) crews, and supporting agency operations.
- Job Corps – Job Corps is a voluntary program that prepares young people ages 16-24 with education and hands-on career training for entry-level positions that lead to careers in today's job market.
- Student Conservation Association – SCA's mission is to build the next generation of conservation leaders and inspire lifelong stewardship of the environment and communities by engaging young people in hands-on service to the land.
- GeoCorps America – The need for geoscience expertise in America's public lands is great. In many cases, geoscience is not adequately addressed in education, resource management, geological hazards mitigation, and research on public lands. Through partnership with USDA Forest Service, under the 21st Century Conservation Service Corps, the Geological Society of America's GeoCorps program strives to increase the number of geoscientists on-the-ground, contributing to the research and protection of geologic resources and developing education and outreach activities.
- **Celebra las Aves (Celebrating Shorebirds)** – This is a Latino student internship specific to bird research and grassroots bird education that is administered by Forest Service through our partner at Environment for the Americas (EFTA). EFTA coordinates International Migratory Bird Day.
- **Great Basin Institute** – The Institute recruits research associates and AmeriCorps fellows for conservation projects across the west in partnership with the Forest Service and other western land management agencies.

Partners

Vital to any citizen science project, partnerships are formal arrangements between the Forest Service and non-Forest Service organizations. There are many benefits to establish partnerships, such as strengthening financial and technical support, linking the agency and stakeholders, educating the public, and increasing common activities across land ownerships. Partners also play a variety of roles including recruiting and managing volunteers, developing research questions, and analyzing data.

How to find a partnership

Talk to your partnership coordinator to find partners who may be interested in joining your citizen science project as well as existing agreements held by your Forest that could help implement it. The Forest Service website has a

page on partnership contacts in regional offices and research stations, Tribal points of contact, and a list of non-governmental organizations the Forest Service often partners with. The Forest Service also works with three congressionally-chartered nonprofit partners:

- The National Forest Foundation
- National Fish and Wildlife Foundation
- National Environmental Education Foundation

Successful partnerships

Partnerships thrive on mutual benefits and objectives, so first, make your goals and intended outcomes clear. Focus on those similarities and work to understand their perspectives. Plan regular meetings with your partners and stakeholders to evaluate your work and solve problems—the more communication and feedback, the better. Prepare to adapt to changing needs and goals of your partners. See the Partnership Guide – a 2014 draft document with comprehensive information on what partnerships are, roles within partnerships, instruments and authorities, working with Indian Tribes, volunteer agreements, and other topics.

Tribes

The Forest Service is committed to strengthening its working relationships with federally recognized Indian Tribes. The agency could partially fulfill this responsibility by partnering with Tribes in citizen science projects. Such partnerships can create a mutually beneficial relationship where Tribes have more opportunities to benefit from Forest Service programs and the agency benefits from tribal guidance and knowledge, specifically Traditional Ecological Knowledge (TEK). TEK, like Western science, rests on the collection of observations. Citizen science projects working with Tribes and using TEK can harmonize the two knowledge systems. TEK may provide new insights into how ecosystems respond to human intervention and changing climate conditions and suggest new strategies to manage forests and grasslands for a variety of economic services, cultural uses, and environmental benefits.

Partners

The Forest Service may enter into agreements, grants, or contracts with tribes, just as it can with other organizations or agencies. It is important to remember, however, that when a tribe joins a partnership or collaborative process, it still maintains a separate governmental relationship with the Forest Service; the partnership or collaborative process is always conducted *in addition* to the separate process of consultation between the agency and the tribe. It is important for members participating in a collaborative process or partnership to understand and respect this unique relationship federal agencies have with tribes.

The following are partners of the U.S. Forest Service Office of Tribal Relations:

- Affiliated Tribes of Northwest Indians
- American Indian Higher Education Consortium
- American Indian Science and Engineering Society
- Indian Nation Conservation Alliance (INCA)

- [Intertribal Timber Council](#)
- [National Congress of American Indians](#)
- [National Museum of the American Indian](#)
- [Native American Fish and Wildlife Society](#)
- [Native Energy](#)
- [Our Natural Resources](#)
- [Society of American Indian Government Employees](#)
- [United South and Eastern Tribes, Inc.](#)

Liasons

Below is a list of Forest Service tribal liaisons:

- Washington Office: [Carl Lucero](#), Director, Landscape Restoration & Ecosystem Research
- Southern Research Station: [Serra Hoagland](#), Biological Scientist
- Rocky Mountain Research Station: [Alison Hill](#), Research Program Manager
- Northern Research Station:
  - [Mike Dockry](#), Research Natural Resource Specialist
  - [Marla Emery](#), Research Geographer
- Pacific Northwest Research Station: [Linda Krueger](#), Research Social Scientist
- Pacific Southwest Research Station: [Peter Stine](#), Director of Partnerships & Collaboration
- Forest Products Laboratory: [Tom Schimdt](#), Assistant Director, Research

You can also contact the [Office of Tribal Relations Staff](#).

Tribal Leaders Directory

To help identify Tribal partners, the Bureau of Indian Affairs has the [Tribal Leaders Directory](#). The electronic, map based, interactive directory provides contact information for Indian Affairs leadership and each federally recognized tribe.

- [Tribal Leaders Directory Map](#)
- [Tribal Directory Dataset](#) (csv)
- [Tribal Directory Dataset](#) (json)
- [Tribal Directory Dataset](#) (xml)
- [BIA Regions Polygon Data for Maps](#) (json)
- [US States Polygon Data for Maps](#) (json)
- [Indian Services Homepage](#)
- [Division of Tribal Government](#)

Additional resources

- **[Resource Assistants Program](#)** – A collaborative effort between the U.S. Forest Service and Salish Kootenai College, the Resource Assistants Program is a paid internship opportunity for those interested in natural and cultural resource careers. These positions are fully funded by the Washington Office and recruitment outreach preference is given to current students especially from minority-serving institutions, recent graduates, and underrepresented populations.
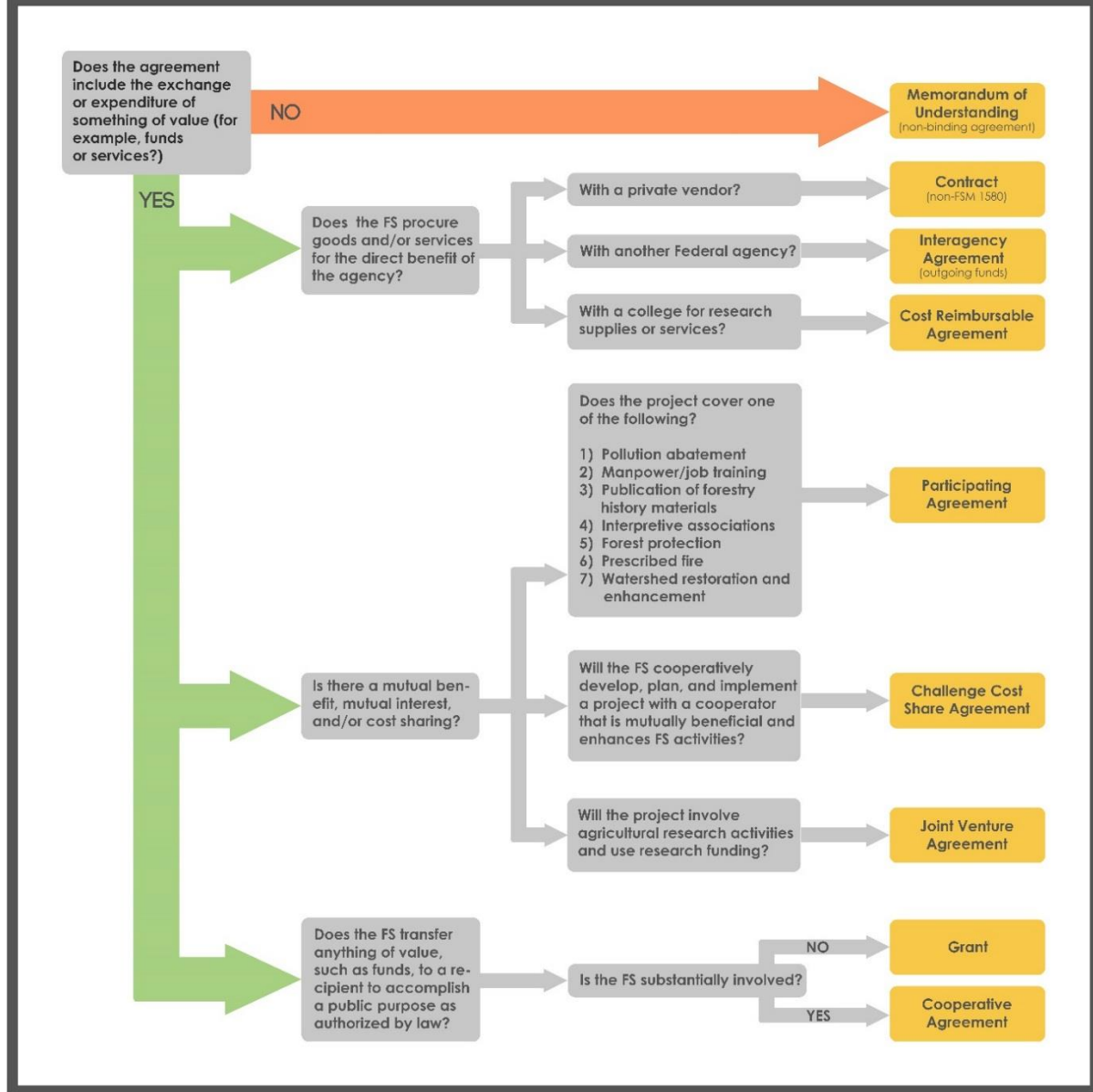
- **Tribal Engagement Roadmap** – The Tribal Engagement Roadmap outlines an agenda for Forest Service Research & Development staff regarding services to, engagement with, and learning from, Indian Tribes and other indigenous groups. A goal of the Roadmap is to advance research on topics of joint interest, such as climate change, fire science, TEK, water protection, fish and wildlife, forest products, restoration, social vulnerability, and sustainability. Learn more through the 2016 Highlights Report.
- **FS National Resource Guide to American Indian and Alaska Native Relations** – The focus of this book is to help Forest Service line officers and employees gain a clear understanding of how to implement the U.S. Government's and the Forest Service's American Indian and Alaska Native policies.

Grants & Agreements

If your project will include the exchange of something of value (i.e. funds or services), then you will need to develop an agreement. Agreements with your partners document roles, responsibilities, and the intent and scale of your project. Detailed guidance and information about establishing agreements with partners can be found in the Partnership Guide.

The flowchart below illustrates which kinds of agreements you should use in a Forest Service citizen science project. It can be a useful tool to start out with, but should not replace discussions between the partner, program staff, and G&A specialists. Those discussions should be ongoing and start early on in the partnership negotiation and continue even after the agreement is executed.

GRANTS & AGREEMENTS FLOWCHART: CITIZEN SCIENCE

Does the agreement include the exchange or expenditure of something of value (for example, funds or services?)

→ **NO** → **Memorandum of Understanding** (non-binding agreement)

YES ↓

Does the FS procure goods and/or services for the direct benefit of the agency?

- With a private vendor? → **Contract** (non-FSM 1580)
- With another Federal agency? → **Interagency Agreement** (outgoing funds)
- With a college for research supplies or services? → **Cost Reimbursable Agreement**

Is there a mutual benefit, mutual interest, and/or cost sharing?

- Does the project cover one of the following?
  1) Pollution abatement
  2) Manpower/job training
  3) Publication of forestry history materials
  4) Interpretive associations
  5) Forest protection
  6) Prescribed fire
  7) Watershed restoration and enhancement
  → **Participating Agreement**

- Will the FS cooperatively develop, plan, and implement a project with a cooperator that is mutually beneficial and enhances FS activities? → **Challenge Cost Share Agreement**

- Will the project involve agricultural research activities and use research funding? → **Joint Venture Agreement**

Does the FS transfer anything of value, such as funds, to a recipient to accomplish a public purpose as authorized by law? → Is the FS substantially involved?
- NO → **Grant**
- YES → **Cooperative Agreement**

Memorandum of Understanding

If the project does *not* include the exchange of funds, services, or something of value, then you may want to develop a Memorandum of Understanding. Memoranda of Understanding are used to document a framework for cooperation between the Forest Service and other parties for carrying out activities in a coordinated and mutually beneficial manner, though each party directs its own activities and uses its own resources. No specific authority needs to be cited, but all activities should be within the Forest Service mission.

Procurement

If the project primarily benefits the Forest Service purpose and no cost sharing is anticipated, it may be a procurement.

- **Contract** – A contract is used when a private vendor does a service for the agency and can be used by any deputy area. Contracts are not covered under Forest Service Manual (FSM) 1580. Visit the [Forest Service website](#) for more information.
- **Interagency Agreement –** This agreement is used when one federal agency provides materials, supplies, equipment, work, or services of any kind that another federal agency needs to accomplish its mission. Some people refer to these as Intra-governmental Orders (IGOs). Do not confuse Interagency Agreements with Intra-agency Agreements between two FS units, which FSM 1580 does not cover.
- **Cost Reimbursable Agreement** – Cost-reimbursable agreements are used when Forest Service research units acquire goods or services, including personnel services, from state cooperative institutions, or other colleges and universities, without seeking competition, to conduct agricultural research of mutual interest. For example, a citizen science project can order services like DNA sequencing from a university lab. Research & Development dollars must be used in a cost-reimbursable agreement.

Partnership Agreements

If the project is of mutual benefit to the Forest Service and a non-federal party, and if there is an exchange of something of value that meets the purpose of both parties, it may be a partnership agreement. Cost sharing should be commensurate with benefits received and a minimum 20% match should be negotiated, unless otherwise stated.

- **Participating Agreement** – Participating Agreements are used when there is mutual benefit, mutual interest, and cost sharing. Often, the project covers pollution abatement, man power/job training, publication of forestry history materials, interpretative association, forest protection, prescribed fire, or watershed restoration and enhancement. In citizen science, participating agreements may also be used to hire Resource Assistants or other staff to assist in running citizen science projects. Typically, NFS dollars are used. If other appropriations are use, it must fit within program funding direction.
- **Challenge Cost Share Agreement** – Challenge Cost Share Agreements are used when there is mutual benefit, mutual interest, cost sharing, and the Forest Service works cooperatively to develop, plan and implement the project. Challenge cost share agreements usually afford more flexibility than participating agreements in that funds can be added when new activities evolve, without having to submit additional paperwork for approval each time a change is made. Challenge Cost Share agreements must emphasize monitoring—not applied research. There is a 20% match required by partner organizations. This cannot be made up of a majority of indirect costs, however, consult with your local grants & agreements specialist since there are no strict rules for the balance between direct and indirect costs. Volunteer hours can be counted as part of a partner match, but there must be a volunteer program in place at the host institution that recognizes them as official volunteers and officially records their hours. National Forest System monitoring dollars must be used.
- **Joint Venture Agreements** – Joint Venture Agreements are used to pool resources in support of agricultural research activities of mutual interest. Parties must share costs and R&D dollars must be used.

Federal financial assistance

If the project serves a public good and meets the intent of a specified assistance authority, then it may be a grant or cooperative agreement. State and private forestry is the deputy area that contributes money to grants and cooperative agreements.

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- **Grant** – Grants are used to transfer money, property, services, or anything of value to an outside group for a project of mutual interest where substantial Forest Service involvement is *not* anticipated. You can apply for a grant through [Grants.gov](https://grants.gov), a centralized source to find and apply for federal grants.
- **Cooperative Agreement** – Cooperative Agreements are used to transfer money, property, services, or anything of value to an outside group for a project of mutual interest where substantial agency involvement *is* anticipated, such approving the next phase of the project.

CHAPTER 4

Design your project & data management plan

A data management plan will help you determine what type of data to collect, how to collect it, and what additional resources you will need when designing your protocol. With good data management, data tools, and quality control measures, data from citizen science projects can meet or even exceed the reliability of conventional science. You can gain quality data from volunteers by ensuring they are properly trained, the protocol is relatively easy to understand and conduct, and you can effectively store and manage data.

Identify quality control measures

Data quality is of high concern for all Forest Service monitoring and research projects. The Forest Service is a science-based organization and the agency's credibility would be damaged if the data used to make land management decisions were found to be unreliable. Volunteers can be just as effective and accurate as professional scientists and technicians as long as your protocol is well defined and volunteers understand how to follow it. Volunteers are often more conscious while collecting data because they do not rely on their professional judgement. Below are suggestions for data quality control measures.

Organizations like the Forest Service rely on the "best available science" when making land management decisions, which does not necessarily have to come from peer-reviewed scientific publications with the most robust designs and inferences. If there is no information in the peer-reviewed literature, the best scientific information *available* is sufficient. (Sullivan et al., 2006). For example, the Kaibab Citizen Science Project had volunteers recording flora, fauna and their locations. The Forest was lacking abundance and distribution data of invasive and rare species, so having forest visitors document their observations helped fill this information gap. Without this effort, the Forest Service wouldn't have had the capacity to supplement the available data.

Assign simpler tasks

One way to control for data quality is to keep the volunteer's tasks simple enough to limit opportunities for human error. Use terms and measurements that easily make sense to volunteers. For example, documenting the presence of one type of rare plant could be significantly easier than identifying up to 50 different mussel species. Either find a way for a professional to join volunteers for surveys, have a professional conduct some quality control on data, or avoid using non-professionals for complicated data collection that cannot be checked for accuracy.

Complete a trial phase

You may also try a "trial phase" of your project to see if your protocol is easily understandable and collects useful information. You might find, for example, that your protocol does not have a realistic expectation of the volunteer's abilities, or that volunteers are observing lots of features you thought would be rare but is now cluttering your data. After the trial phase, you can modify the protocol as appropriate.

Test with professionals

If possible, you might consider selectively repeating your protocol with professional scientists/technicians to test for quality control.

Monitor volunteers

Individual volunteers should be evaluated to make sure protocols are being followed so that data is reliable and useful. This usually happens by compiling notes from data and sharing the best examples. If there are a significant amount of mistakes it might be best to display examples anonymously and without embarrassing anyone. Some less common mistakes might be best discussed on an individual basis.

Design your protocol

How will you collect your data? First, decide whether your project's data collection will work best in an online or field environment. Is this a project where participants can be trained and collect information virtually without needing in-person support, or is the project site-specific and formatted to have in-person training or data collection? Would this information be best collected on a paper form or in an app?

Paper forms

If you plan to collect data by having volunteers fill out paper forms, make sure volunteers know how and when to turn in data sheets. Consider entering data within 48 hours of collection rather than at the end of the season, and check if you have the staff time to upload the data to the relevant databases (e.g., Forest Service Natural Resource Manager databases and federal databases like the breeding bird survey). If that turns out to be too difficult, you might consider other options to enter data – for example, working with a partner like a state natural heritage program. Some projects require mail-in forms; consider how you will track and properly enter them.

Apps

Many projects can collect and store data with just volunteers and their smartphones or simple measurement tools that your unit likely already owns. Of course, relying solely on mobile devices can limit the ability to collect data in isolated areas and exclude people who do not use smartphones. Many apps currently allow users to collect data in areas that are out of service and then upload them when they reach service again – this should be researched ahead of time. Location accuracy of different devices and settings required to receive the proper metadata (e.g., must turn on location service) also need to be considered.

There are countless citizen science apps already out there, and you can even develop your own using ArcGIS Online. Listed below are some commonly used citizen science apps.

- **Tools from ESRI**: The Forest Service has an institutional subscription for ESRI GIS mapping tools, some of which can be used to collect data for citizen science. Collector, Survey123, and GeoForm can be used to develop custom apps and forms for your project. ESRI has a page with citizen science resources, and the Forest Service Citizen Science and Crowdsourcing Community of Practice has held several webinars on ArcGIS Online (AGOL) tools.
    - **Collector** – View the webinar here.

- o **Survey123** – View the webinar [here](#).
- o **GeoForm** – Webinar is not available at this time

- **eBird App:** Developed and managed by the Cornell Lab of Ornithology, eBird is an app and website for documenting bird abundance as well as the presence or absence of species. Birders simply enter when, where, and how they went birding, then fill out a checklist of all the birds they saw or heard during the outing. eBird provides various options for data gathering including point counts, transects, and area searches. Automated data quality filters developed by regional bird experts review all submissions before they are entered into the database, while local experts review unusual records that are flagged by the filters. eBird data are accessible to anyone via the eBird website and is integrated into the [Avian Knowledge Network](#).

  [iNaturalist App](#): iNaturalist is a smartphone app and website that can be used for recording observations of living things anywhere in the world. iNaturalist volunteers capture photos or sounds and upload them to the app or website. The observation can in turn be downloaded from the site as a KML or CSV and uploaded to ArcGIS. Users can identify their observation themselves, or they can simply give it a broad label like plant or mammal and iNaturalist's community of experts will identify the picture. As of July 2017, iNaturalist automatically suggests an ID based on machine pattern recognition and what species are found in the area. Enter the geographic area where you are interested in gathering data, i.e. your Forest or Ranger District, and invite other users to join this project and upload their observations. A good example of the Forest Service using iNaturalist volunteers is the [Kaibab National Forest Citizen Science Project](#). A downside to iNaturalist is that the forms and information collected cannot be customized.

- *More apps and programs will be added.*

Scheduling collection times[20]

If possible, have double assignments on the same sites. This will help ensure full data sets in case of volunteers quitting or unexpected absences. Volunteers tend to feel camaraderie with those on the same site and also relief in case they cannot make the full commitment as intended. Some project leads have found that having 3-4 people per site at one time is the most sustainable depending on the amount of work needed.

If volunteers go out as a group with a Forest Service staff lead or partner lead, establish clear scheduling expectations and how they will be determined. Also, make it very clear how cancellations and changes will be communicated and when. For group monitoring dates, you may decide to use an online scheduling poll, like [Doodle,](#) to easily determine everyone's availability and to pick the best date.

An end-of-season wrap up is recommended even though this may not allow enough time to have the current data compiled. It's a good way to collect feedback, thank volunteers and discuss observations in person. To condense gatherings you may consider combing season wrap ups for multiple monitoring programs so everyone can meet each other and hear about other wildlife programs too.

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[20] Section taken from Midewin Tallgrass Prairie Citizen Science Best Practices

Decide how you will analyze data

Who will analyze your data and how will they do it? This depends on your project design and goals. For example, youth centered projects often involve participants in analysis of data for educational benefits. In this case, consider the space, time, computers, and applications students might need to analyze data – a local school or college may be able to provide classrooms and computer labs. In other projects, resource specialists or researchers (who could come from either the Forest Service or other entities) undertake data analysis.

Ensure data preservation & availability

Though it depends on what kind of data you are collecting and its intended end use, it is important to ensure the data you have collected is easily available to Forest Service staff. Since there is often high turnover in Forest Service units, ensure the data will be accessible to staff who may join the unit in the future or if you leave the unit or the agency entirely.

Upload your data to the relevant FS enterprise database if possible. Evaluate ahead of time which data need to be restricted from public access (e.g., heritage or wildlife data) and confirm your data collection tool and/or method of sharing allows for privacy of sensitive information.

Plan to preserve your data for the long term, meeting agency data retention policies and practices as well as the standards of the National Archives and Records Administration.

CHAPTER 5

Prepare for volunteers

The [Volunteers in the National Forests Act of 1972](), as amended, 16 U.S.C. 558a-558d grants the Secretary of USDA the authority to recruit, train, and accept the services of individuals as volunteers on national forests. A volunteer is a person or group of persons who donate their time and talent to work with Forest Service staff on agency projects and who receive no salary or wages from the Forest Service for their voluntary service. Once you understand what your data needs and protocols are, you will know what the skill set and requirements of your volunteers will be.

Volunteer position descriptions[21]

Develop volunteer position descriptions that are thorough and honest about what the monitoring program will entail. Do not advertise a program as "no experience necessary" if there are not sufficient training opportunities offered by the unit or partners.

- **Purpose** – Include the unit, state, regional impact, and what part of the mission the program supports.
- **Duties and Responsibilities** – Explain the nuts and bolts of what is required to fulfill the program needs.
- **Department** – List the department and staff member(s) that will be the main contact for the volunteer and where the monitoring site could be (maybe within a general range).
- **Location** – State where the activities will take place and where the volunteers will go to be trained.
- **Qualifications** – State the minimum requirements and expectations to complete the tasks including if training in specialized equipment or software is necessary or provided.
- **Time Commitment** – List the time commitment in the protocols such as number of days, hours per day, and number of surveys. Include weekday, weekend, and evenings as they apply. State if a multi-year commitment is required or preferred. Tip: shifts longer than 4-5 hours are not popular with volunteers.
- **Training** – List the minimum training that the unit will provide and any ongoing or off-site training required or recommended. This should include any estimated costs that the volunteer will incur.
- **Working Conditions/Physical Effort** – Give volunteers a good vision of the likely conditions. Consider including injurious/poisonous plants, possible animal encounters, and seasonal weather conditions.
- **Benefits** – List some fun experiences or benefits volunteers can count on such as knowledge, skills, invitations to volunteer gatherings, awards, health benefits, etc.
- **Related Opportunities** – If the volunteer likes this opportunity, they might like more responsibilities within this role or an additional program.

Volunteer recruitment strategy

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[21] Section taken from the Midewin Tallgrass Prairie Citizen Science Best Practices

Your outreach may depend on how many volunteers are needed and what special interests or skills you are looking for. Do you need to cast a broad net or target specialty groups? Listed below are ways to reach and recruit potential volunteers.

- **Partners** – Past citizen science projects have had success in recruiting volunteers through partner organizations with strong volunteer bases or through working with local teachers and schools. One example is [Adventure Scientists](), an organization that recruits highly skilled volunteers (such as mountaineers) to collect conservation data for partners like the Forest Service.
- **Volunteer Groups** – Collaborate with other Forest Service staff such as [Volunteers & Service](), [Conservation Education](), etc. Your local partnership coordinator will be able to identify local partner and volunteer groups to work with.
- **K-12 Classrooms** – Talk to teachers and principals to collaborate with classrooms focused on STEM topics or hands-on activities for students.
- **Events** – Engage diverse audiences through community organizations and large "walk-in" events, such as town events and career fairs.
- **Volunteer.gov** – [Volunteer.gov]() is an online portal for government agencies, including the Forest Service, to list volunteer opportunities and connect with interested volunteers. Contact [emailbox@xmission.com]() for access to list your volunteer opportunity.
- **Online Media** – Use social media, blogs, and videos. The Forest Service has accounts on [Facebook](), [Twitter](), and [YouTube](), and blog posts on the [Forest Service blog]() and [Citizen Science blog](). Individual National Forests also have accounts on Facebook and Twitter. Use the social media accounts of the Forests your project is based in to get the word out to interested parties.
- **Printed Media** – In a survey by The Nature Conservancy, it was reported that the #1 reason someone started volunteering is because they have physically been to that place. This calls for a targeted effort to turn visitors into volunteers. Post paper fliers on message boards in popular locations on the unit, e.g., visitor centers, supervisor's office, campgrounds, and trailheads.

Volunteer agreements & forms

Volunteer services are covered in [Forest Service Manual (FSM) 1800: Volunteers and Service](). Volunteers typically enroll using the Official Form 301a (Volunteer Service Agreement), but some are recruited by partners (and are therefore not Forest Service volunteers) so may instead be reflected on a [Grants & Agreements]() form. The suite of volunteer forms and documents are available on the [Volunteers Share Point Site](), which is internal to the Forest Service (click on Volunteer Program Forms and download the zip file). Listed below are links to some of those documents.

- **[Volunteer Service Agreement (301a)]()** – All volunteers must complete a Volunteer Service Agreement (301a), which allows the Forest Service to legally accept volunteer service. A **[Group Sign-up (301b)]()** can be used for large "walk-in" citizen science events in place of 301a. Both 301a and 301b agreements include full liability coverage for the volunteer (tort liability and workers compensation coverage), and should to be sent to the Albuquerque Service Center for reimbursement claims. Volunteers under age 18 must have their form signed by a parent or guardian. The content can be amended at any time by consent of both parties if volunteer duties change. No match is required, and volunteers or volunteer partners may be

reimbursed for out-of-pocket expenses. If volunteers will be riding in Forest Service government vehicles, they will need to sign a ride-along form – check with your local or regional volunteer coordinator to find out more.

- **Volunteer Application** – This application helps public land officials and potential volunteers determine if there are volunteer opportunities that are a good match for their skills and interests. All volunteers are required to complete a volunteer agreement once they have committed to a specific volunteer activity.
- **Photo Release** – If you are to take or use photos of volunteers, they must complete a photo release before you can use those photos in promotional materials, websites, or any in any way.

Volunteer training

Before any field work begins, schedule a training session to make sure volunteers understand the protocol, safety concerns, how the data they collect will be used, and the project as a whole. A volunteer list would serve to announce trainings or gatherings.

Introduce volunteers to the project and each other

The more connected the new volunteer feels at the beginning, the higher the retention rate. Introduce volunteers to each other, the site's history and mission, and the big picture and purpose of the program, along with any data/trends documented so far.

Describe the level of knowledge necessary

The quality of your data depends on the volunteers' knowledge of the protocol and commitment to following it correctly. Ensure volunteers understand the protocol well enough to contribute quality and usable data. If your protocol is relatively complex, you could arrange for a separate training session before the day they are scheduled to volunteer. If you cannot provide sufficient training, be clear and explicit while recruiting volunteers about what they will already need to know. If the project is simple and has team leaders on site with volunteers already well-versed in the protocol, a set of instructions at the beginning of the field day will suffice.

Data usage & ownership

The Crowdsourcing and Citizen Science Act of 2017 requires that "As part of the consent process, the Federal science agency shall notify all participants (i) of the expected uses of the data compiled through the project; (ii) if the Federal science agency will retain ownership of such data; (iii) if and how the data and results from the project would be made available for public or third party use; and (iv) if participants are authorized to publish such data."

Safety

Make sure to include safety measures while training volunteers. Reference Job Hazard Analysis so volunteers understand any relevant safety risks. Immediately after an accident or near miss, Forest Service employees shall notify the appropriate authorities in the manner specified in FSH 6709.11. All Worker Compensation claims go through the Albuquerque Service Center.

Training session tips

- **Get them used to the environment** – An on-site, field orientation is the best choice especially for new volunteers. It doesn't have to be at the exact site of your project, but a good representation.
- **Provide additional training** – Give volunteers the option of furthering their knowledge of the training material with online resources, webinars, books, and local presentations.
- **Let volunteers learn from each other** – It may to useful to have new volunteers join seasoned volunteers for the first couple of dates or the full season, versus starting new volunteers on their own site right away. If a volunteer feels too intimidated as beginner, they are more likely to drop out of a project. You might consider requiring all experienced volunteers to announce their first monitoring dates and allow the newer volunteers to join. This makes it a fair and shared responsibility to help newcomers. This also gives the newcomers several options for dates and a diversity of sites to train on.
- **Use photography and video** – Encourage volunteers to take photos of themselves and things that represent the program so they can be used in presentations or success story articles. Ask specifically for photographs showing faces and actions in order to get the most usable photos. Videos should be creative, and also appropriate – make sure participants know the expectations for video content including using the proper protective equipment.

Develop a field manual or an online training video

It is helpful to develop a written field manual/protocol to make sure that everyone is clear on the information to be collected and the way in which it should be collected. Use as many visual aids as possible to help volunteers for example, plant identification guides and step-by-step visual instructions for using measuring instruments. Training videos are also helpful so volunteers can reference them throughout the project.

Disengage or reassign

Retain volunteers by having a monthly check-in meeting of volunteers with Forest Service staff, and distribute a quarterly e-newsletter. Inform your email list of volunteer positions and events. Develop social media networks where volunteers can talk to one another and learn about how their data is being used for land management or furthering science.

Address volunteer burn out, change in physical condition, or availability.

- If a volunteer's availability decreases but they want to continue monitoring their site, decide if partial data is still useful.
- Are there ways a volunteer can still help on a different schedule or in an office environment?
- If replacements need to be recruited, encourage the former volunteer to go out for at least one survey or season to train a new volunteer.

Reward volunteers & partners

Make sure volunteers and partners see the end result of their efforts by inviting them to a presentation or allowing them a space to present their findings themselves. Thank them for their work at the presentation and send them copies of any publications resulting from their efforts. Listed below are awards you can use to recognize the efforts of volunteers and partners.

- **President's Volunteer Service Award** – Recognizes U.S. citizens and lawfully admitted permanent residents who achieve the required number of volunteer service hours over a 12 month time period or cumulative hours over the course of a lifetime.
- **Volunteers & Service Annual Awards Program** – Recognizes partners, volunteers, and staff for their contributions in five categories: Citizen Stewardship & Partnerships, Cultural Diversity, Enduring Service, Leadership, and Restoration. Includes letters from Chief with awards.
- **Chief's Honor Award** – This is the highest honor in the Forest Service and recognizes agency employees who find innovative ways to perform work according to our national priorities and strategic plan.
- **Rise to the Future** – recognizes outstanding individual and group achievements by natural resource professionals in the Forest Service, as well as our partners in the fisheries, hydrology, soil, and air programs.

Other reward ideas:

- **Interagency Volunteer Pass** – Covers federal public lands site fees for 12 months
- **1,000 Hour Certificate** – One-time recognition signed by Chief
- **Volunteers & Service Appreciation Certificate** – FS unit can sign
- **Potluck/picnic ceremony** – Hold a gathering the day of the event or end of the "season"; buy a cake
- **Share their stories** – Write a blog post or send out an email (use photo releases)

CHAPTER 6

Develop your project evaluation

While implementing your project, it must be evaluated regularly to see if it is meeting its purpose and delivering useful data. The goal is to adjust your project based on the evaluation's findings. This chapter will help you plan your evaluation – when it will take place, who will carry it out, what questions you will ask, and how you will record the answers to those questions.

When is the evaluation?

Scheduling periodic reviews of your citizen science project improves the likelihood that the evaluations will be conducted when needed. Evaluations are typically done after the project's first year or season. All aspects of the project don't necessarily need to be reviewed at the same time, at the same intervals, or by the same individuals.

Who will perform the evaluation?

Determine who will be the individuals responsible for carrying out the evaluation.
- **Independent Reviewers** – Reviewers without a vested interest in the project can assist the review process by providing an outside perspective and by addressing issues that participants may find controversial or hard to discuss honestly. Scientists or government researchers can recommend independent reviewers.
- **Project Team** – Forest Service personnel and partners can also be evaluators. If any or all partners were not involved in developing the project, their involvement in the evaluation process would enable them to become more familiar with the project and gain a new or expanded interest in the project's success.
- **Volunteers** –It would be highly beneficial during the implementation step to have a feedback mechanism from the volunteer group.

What are the questions?

Identify the questions you must answer. Some of these questions should be asked of volunteers – it is important to know their opinions on what worked and what didn't. Answers to these questions can be either quantitative (for instance, numerically scored questionnaires) or qualitative (such as group discussions).

Some evaluation questions can be found in the USFS General Technical Report Broadening Participation in Biological Monitoring: Handbook for Scientists and Managers. Take a look at these questions below and see which are applicable to your citizen science project.

- Is the chosen participatory approach the best way to meet identified needs for biodiversity or land management and other project goals (i.e. goals for public engagement)?
- Is the documented project plan adequate and useful?
- Should the project be discontinued at some point, and if so, when or under what circumstances?

- Do project monitoring goals or targeted indicators need to be altered?
- Were any contextual considerations overlooked?
- Is the organizational structure of the project meeting the needs of the participants and achieving the goals of the project?
- Does the project adequately represent all interested stakeholders and have a sufficient number of participating individuals?
- Are the project partners and volunteers communicating and making decisions well?
- Are participants' needs and expectations being met? Are there any difficulties with sustaining involvement and commitment? Is the project stagnating or becoming inflexible?
- Are the participants finding the experience personally rewarding?
- Have participant skills and expertise been appropriately matched to tasks?
- Are resources being budgeted and used efficiently? Are additional resources needed to achieve the goals?
- Is the project being conducted in a safe manner?
- Are training, field procedures, logistical arrangements, and support activities adequate?
- Are the sampling design and protocols adequate and appropriate?
- Have education outcomes been achieved for K-12 programs?

Individual participants should also be evaluated to make sure protocols are being followed so data is reliable. This usually happens by compiling notes from data and sharing the best examples. If there are a significant amount of mistakes it might be best to display examples anonymously and without embarrassing anyone. Some less common mistakes might be best discussed on an individual basis.

How will the answers be recorded?

Determine how you will record, summarize, and document the evaluation. That way, the results can be more easily incorporated into project revisions.

CHAPTER 7
Share your results

Share your data by providing the simplest possible tools or methods for data visualization, evaluation, and data download. Track your results using internal databases, share your results to outside groups, and create a public community that sustains your project's momentum.

Track your results internally

After you have completed your project—or at least a segment of it—report what you have done so the Forest Service as a whole can know what you're doing and can better support and communicate your efforts.

- **VSReports** – The Volunteer and Service Reports database is used to report partnerships, participants, activities, and outcome data for all Volunteers & Service programs and projects.
- **NICE** – The NatureWatch, Interpretation and Conservation Education database (NICE) is used to report all Conservation Education, NatureWatch, Interpretation and related programs for which the Forest Service provides funds and/or staff time. For the purposes of reporting, an accomplishment is defined as an educational program, experience and/or activity that enables people to understand and appreciate natural resources and learn how to conserve them for future generations. See the NICE User's Manual.
- **Natural Resource Manager (NRM)** – The Natural Resource Manager (NRM) is a system of database tools for managing Agency data across the Forest Service and for most of the agency's natural resource business areas. The NRM includes: *Forest Service ACtivity Tracking System (FACTS)*, *Infrastructure (Infra)*, *Natural Resource Information System (NRIS)*, and *Timber Information Manager (TIM)* applications.**Treesearch** – The Forest Service tracks citizen science research through keywords in research publications. If you publish an academic paper on your citizen science work, use 'citizen science' in your article keywords so it can easily be found in Treesearch.

Determine when to enter data into VSReports or NICE (or both)		
Please contact your regional coordinator for volunteerism and service if you have questions		
Activity Type	☐ Outreach ☐ Education ☐ Volunteerism	
Majority of Activity (select one)	☐ Outreach ☐ Education ☐ Volunteerism	
	NICE	**VSReports**
Application Description	A web application for outreach and education activities and accomplishments accessible by the public, partners, and leadership.	A web application for FS volunteer, community and national service partnerships and accomplishments accessible only by individuals with Forest Service accounts.
Purpose	Capture outreach and education programs for which the Forest	Compile volunteers and service performance data to inform

	Service provides funds and/or staff time.	budget, reporting and program planning.
Programs / Authorities / Forest Service Manual or Handbook	NatureWatch, Every Kid in a Park, Conservation Education, Interpretations, National Environmental Education Act, FSM 1620, 2390, 2500, 2600	Volunteers in National Forests Act, 21st Century Conservation Service Corps, Public Lands Corps Act, Youth Conservation Corps Act, Service America Act, FSM 1810, 1820, 1830, 1840 and 1850
Type of Activities	An education program, experience and/or activity that encourages people to understand and appreciate natural resources and learn how to conserve them for future generations.	Volunteerism, 21SCSC projects including RAP, and other partnerships that engage youth to age 30 and veterans in work on Forest lands.
Reporting Due Date	October 15	October 15, extended to November 10
Application url	https://apps.fs.usda.gov/nice/f/welcome	https://apps.fs.usda.gov/vsreports/
FS Deputy Area & Unit	SPF, Conservation Education NFS, Wildlife, Fish & Rare Plants	NFS, Recreation, Heritage & Volunteer Resources
WO Contact	Sue Cummings, scummings@fs.fed.us Kimberly Winter, kawinter@fs.fed.us	Merlene Mazyck, mmazyck@fs.fed.us

Share your data externally

Data is more useful and can have a greater impact if it's shared beyond your individual project. Information from the Forest Service is served to the public in the following databases:

- **Enterprise Data Warehouse (EDW)** – The EDW is a repository of Forest Service data with the goal of integrating data from various sources in formats that can be easily used for reporting and analysis and that can be shared across the agency. By entering quality data into NRM, your data will automatically be refreshed in the EDW. Additionally, these authoritative datasets are made accessible to everyone through applications such as ESRI ArcGIS Online.
- **Data.gov** – This website provides descriptions of the Federal datasets (metadata), information about how to access the datasets, and tools that leverage government datasets. Data from the EDW is also shared with data.gov.
- **Geospatial Platform** – The Geospatial Platform is a managed portfolio of common geospatial data, services, and applications contributed and administered by authoritative sources and hosted on a shared infrastructure for use by government agencies and partners to meet their mission needs.

Share your results

Report the results of your project and how it's used to further land management or science. You can do this through written project reports, technical guides, peer-reviewed publications, presentations at conferences, public webinars, or by using modern technologies such as ESRI Story Maps. Ensure that when your project comes to an end, you have a public-facing presentation of the results instead of an abandoned-looking website.

- **Citizen Science Association** – The Citizen Science Association aims to bring together the expertise of diverse practitioners working in the field of citizen science to share the breadth of resources and best practices across different citizen science project types. Share your peer-reviewed publications at the Citizen Science Association's annual conference and in their science journal – Citizen Science: Theory and Practice.
- **Federal Projects Catalog** – The General Services Administration tracks federal citizen science projects through the Federal Projects Catalog. The purpose of this catalog is to improve cross-agency collaboration, reveal opportunities for new high-impact projects, and make it easier for volunteers to find projects they can join. Submit your project to the catalog and it will be reviewed by the Washington Office before it goes live.
- **Forest Service Citizen Science and Crowdsourcing Community of Practice (FSCCS)** – The goal of the FSCCS is to create a virtual meeting space where participants can network, learn from colleagues and partners, connect to resources and information, and be inspired to develop new projects or expand their current crowdsourcing and citizen science projects. These monthly calls are open to anyone (Forest Service, partners and general public). To learn about upcoming webinars and sessions, join our mailing list. If you have a project you'd like to highlight or get feedback on, send a message to fsccs@fs.fed.us with subject line, "Presentation", and we'll get you on the schedule!

Create a community

Establish a social media account, iNaturalist group, or other designated place where people can create a community surrounding your project and keep its energy flowing. Reach out to new volunteers and partners and connect their projects with your own through in-person gatherings, conferences, and volunteer events. Host educational follow-ups and presentations, and let people know how their contributions have been used.

The links below should get you started. Make sure to celebrate Citizen Science Day with your partners and community on Saturday, April 14, 2018.

Online media

Post your accomplishments online with the following resources. To catch more attention, include photos and/or video of volunteers in your posts. Photos tend to be more interesting if they feature people working on the project rather than merely smiling for the camera.

- **Facebook & Twitter** – Social media platforms are great avenues to let people know about your project (see the official Forest Service Facebook, Twitter, YouTube, Instagram, and Flickr). Individual forests and partners often have social media accounts where you can share your announcements. For example, if your project is based on the Tongass National Forest and has Trout Unlimited as a partner, post your content

on the official [Tongass National Forest Facebook](), [Twitter](), and [Flickr]() pages as well as [Trout Unlimited Facebook]() and [Twitter]().

- **Blog post** – Consider writing a blog post about your project that can be shared on the social media pages discussed above. There are many websites where you can write a blog post, such as the [Forest Service Citizen Science Stories](), [Forest Service Blog](), the [Federal CitSci Blog]().
- **Hashtags** – You may want to include hashtags to help people find your post, such as #CitizenScience #CitSci, #CitSciDay, #DiscovertheForest, or any other tag related to your post that would bring it to the top of search results. Associate it with the Forest Service by using an official handle such as @ForestService
- **Flickr** – Upload the photos you take during your project and upload them to your Forest's [Flickr]() account. Flickr can make your photos easier to access and share in large sizes.

HYPERLINKS

INTRODUCTION

MAIN TEXT	
Federal Citizen Science Toolkit	https://crowdsourcing-toolkit.sites.usa.gov/
2017 Crowdsourcing and Citizen Science Act, Section 402	https://www.congress.gov/bill/114th-congress/senate-bill/3084/text
Cornell Lab of Ornithology Citizen Science Toolkit	http://www.birds.cornell.edu/citscitoolkit/toolkit
UK Environmental Observation Framework	https://www.ceh.ac.uk/sites/default/files/citizenscienceguide.pdf
RELATED LINKS	
General Technical Report: Broadening Participation in Biological Monitoring: Handbook for Scientists and Managers	https://www.fs.fed.us/pnw/pubs/pnw_gtr680.pdf
Citizen science, crowdsourcing and related terms	https://www.digitalgov.gov/2015/12/16/challenges-crowdsourcing-citizen-science-whats-the-dif/
McKinley, D.C., et al., *Citizen science can improve conservation science, natural resource management, and environmental protection*. (Biological Conservation 2016)	https://www.researchgate.net/profile/Abraham_Miller-Rushing/publication/311668147_Citizen_science_can_improve_conservation_science_natural_resource_management_and_environmental_protection/links/586cca9108ae8fce4919f411.pdf

CHAPTER 1 – Determine if citizen science is right for your project

MAIN TEXT	
Four Forests Restoration Initiative	http://fourforestrestorationinitiative.org/
RELATED LINKS	

Scope Out the Problem – Federal Citizen Science Toolkit	http://bit.ly/2FLrSWq

CHAPTER 2 – Start with the basics

MAIN TEXT	
Federal Citizen Science and Crowdsourcing Catalogue	https://ccsinventory.wilsoncenter.org/
Cornell Laboratory of Ornithology Citizen – Science Central	http://www.birds.cornell.edu/citscitoolkit/login_form?came_from=http%3A//www.birds.cornell.edu/citscitoolkit/projects&retry=&disable_cookie_login__=1
SciStarter	https://scistarter.com/
CitSci.org	http://citsci.org/cwis438/Browse/Project/Project_List.php?WebSiteID=7
Forest Service Monitoring Protocols	https://www.fs.fed.us/emc/rig/protocols/master.shtml
National Environmental Methods Index (NEMI)	https://www.nemi.gov/home/
Global Learning and Observations to Benefit the Environment (GLOBE) Program	https://www.globe.gov/do-globe/globe-teachers-guide/
Forest Service Citizen Science Competitive Funding Program	https://www.fs.fed.us/working-with-us/citizen-science/competitive-funding-program
Grants.gov	http://www.grants.gov/
federal grant-making agencies.	http://www.grants.gov/web/grants/learn-grants/grant-making-agencies.html
Federal and Private Grant Funding Resources	http://www.fs.usda.gov/detail/prc/tools-techniques/funding/?cid=STELPRDB5200611
Partnership Grant Calendar	http://www.fs.usda.gov/detailfull/mbs/workingtogether/partnerships/?cid=stelprdb5158088&width=full#aug2016

Start a Partnership With the USDA Forest Service or Obtain Federal Financial Assistance: A guide for Tribal Governments	https://www.fs.fed.us/spf/tribalrelations/documents/tools/StartPartnershipTribalGuide.pdf
Matching Awards Program	https://www.nationalforests.org/grant-programs/map
Crowd Funding, check out this 1-page document that provides an overview.	https://www.fs.fed.us/sites/default/files/prc-howcrowdfundingworks.docx

RELATED LINKS	
Manage Your Data – Federal Citizen Science Toolkit	https://crowdsourcing-toolkit.sites.usa.gov/step-4-manage-your-data/
Design a Project – Federal Citizen Science Toolkit	https://crowdsourcing-toolkit.sites.usa.gov/step-2-design-a-project/

CHAPTER 3 – Build your team

MAIN TEXT	
Volunteers in the Forest Service: A Guide for Coordinators	https://www.fs.fed.us/eng/pubs/htmlpubs/htm09672814/page15.htm
Resource Assistant Program	http://www.fs.fed.us/working-with-us/volunteers/resource-assistants-program
Celebra las Aves (Celebrating Shorebirds)	http://www.environmentamericas.org/connecting-cultures/internships/celebrate-shorebirds/
Great Basin Institute	https://www.thegreatbasininstitute.org/
GeoCorps	https://www.geosociety.org/geocorps/
page on partnership contacts in regional offices and research stations,	https://www.fs.fed.us/about-agency/partnership-resource-center/regional-partnership-contacts
Tribal points of contact	https://www.fs.fed.us/spf/tribalrelations/contacts/index.shtml
list of non-governmental organizations	https://www.fs.usda.gov/detailfull/prc/people/resource/?cid=STELPRDB5202586&width=full
The National Forest Foundation	https://www.nationalforests.org/

National Fish and Wildlife Foundation	http://www.nfwf.org/Pages/default.aspx
National Environmental Education Foundation	https://www.neefusa.org/
Partnership Guide	https://www.fs.usda.gov/detail/prc/tools-techniques/partnership/?cid=stelprdb5438298
Tribes and Climate Change Project	https://www.fs.fed.us/research/tribal-engagement/climate-change.php
U.S. Forest Service Office of Tribal Relations	https://www.fs.fed.us/spf/tribalrelations/
Affiliated Tribes of Northwest Indians	http://www.atnitribes.org/
American Indian Higher Education Consortium	http://www.aihec.org/
American Indian Science and Engineering Society	http://www.aises.org/
Indian Nation Conservation Alliance (INCA)	http://www.inca-tcd.org/
Intertribal Timber Council	http://www.itcnet.org/
National Congress of American Indians	http://www.ncai.org/
National Museum of the American Indian	http://www.americanindian.si.edu/
Native American Fish and Wildlife Society	http://www.nafws.org/
Native Energy	http://www.nativeenergy.com/
Our Natural Resources	http://www.ournaturalresources.org/
Society of American Indian Government Employees	http://www.saige.org/
United South and Eastern Tribes, Inc.	http://www.usetinc.org/Home.aspx
Carl Lucero, Director, Landscape Restoration & Ecosystem Research	https://www.fs.fed.us/research/people/profile.php?alias=cflucero
Serra Hoagland, Biological Scientist	https://www.fs.fed.us/research/people/profile.php?alias=sjhoagland
Alison Hill, Research Program Manager	https://www.fs.fed.us/research/people/profile.php?alias=ahill01

Mike Dockry, Research Natural Resource Specialist	https://www.fs.fed.us/research/people/profile.php?alias=mdockry
Marla Emery, Research Geographer	http://www.fs.usda.gov/research/people/memery
Linda Krueger, Research Social Scientist	https://www.fs.fed.us/research/people/profile.php?alias=lkruger
Peter Stine, Director of Partnerships & Collaboration	https://www.fs.fed.us/research/people/profile.php?alias=pstine
Tom Schimdt, Assistant Director, Research	https://www.fs.fed.us/research/people/profile.php?alias=schmidt
Office of Tribal Relations Staff	https://www.fs.fed.us/spf/tribalrelations/contacts/index.shtml
Tribal Leaders Directory	https://www.bia.gov/tribal-leaders-directory
Tribal Leaders Directory Map	https://www.bia.gov/sites/bia.gov/libraries/maps/tld_map.html
Tribal Directory Dataset (csv)	https://www.bia.gov/sites/bia.gov/files/assets/mapfiles/TribalLeadersDirectory.csv
Tribal Directory Dataset (json)	https://www.bia.gov/sites/bia.gov/files/assets/mapfiles/TribalLeadersDirectory.json
Tribal Directory Dataset (xml)	https://www.bia.gov/sites/bia.gov/files/assets/mapfiles/TribalLeadersDirectory.xml
BIA Regions Polygon Data for Maps (json)	https://www.bia.gov/sites/bia.gov/files/assets/mapfiles/BIARegionPolygonGeo.json
US States Polygon Data for Maps (json)	https://www.bia.gov/sites/bia.gov/files/assets/mapfiles/USStatesGeo.json
Indian Services Homepage	https://www.bia.gov/bia/ois
Division of Tribal Government	https://www.bia.gov/bia/ois/tgs
Resource Assistants Program	http://skctrees.org/wp-content/uploads/2017/09/SKC-RAP-Outreach-Notice.pdf

Tribal Engagement Roadmap	https://www.fs.fed.us/research/docs/tribal-engagement/consultation/roadmap.pdf
2016 Highlights Report	https://www.fs.fed.us/sites/default/files/fs_media/fs_document/5082_tribalrd.pdf
FS National Resource Guide to American Indian and Alaska Native Relations	https://www.fs.fed.us/spf/tribalrelations/pubs_reports/NationalResourceGuide.shtml
Forest Service website	https://www.fs.fed.us/working-with-us/contracts-commercial-permits/how-to-contract-with-forest-service
Grants.gov	https://www.grants.gov/
RELATED LINKS	
Bureau of Indian Affairs Useful Links	https://www.bia.gov/knowledge-base/useful-links
Sacred Sites	https://www.fs.fed.us/spf/tribalrelations/sacredsites.shtml
Start a Partnership with the USDA Forest Service or Obtain Federal Financial Assistance - A Guide for Tribal Governments (PDF, 2.0 MB)	https://www.fs.fed.us/spf/tribalrelations/documents/tools/StartPartnershipTribalGuide.pdf
A Guide to Tribal Governments Overview (PDF, 1.3 MB)	https://www.fs.fed.us/spf/tribalrelations/documents/tools/TribalGuideForestServiceGrantsAgreements.pdf

CHAPTER 4 – Establish your project design & data management plan

MAIN TEXT	
GIS Tools from ESRI	http://www.esri.com/arcgis/about-arcgis
page with citizen science resources	https://blogs.esri.com/esri/arcgis/2015/09/22/citizen-science-resources/?utm_source=esri&utm_medium=blog&utm_term=130902&utm_content=blog&utm_campaign=citizen_science_webinar_092315
Collector	http://doc.arcgis.com/en/collector/
Collector webinar	https://usfs.adobeconnect.com/p17lpc9fgwem/?launcher=false&fcsContent=true&pbMode=normal
Survey123	http://www.esri.com/products/survey123

Survey 123 webinar	https://usfs.adobeconnect.com/pxors2342qn0/?launcher=false&fcsContent=true&pbMode=normal
GeoForm	https://www.arcgis.com/home/item.html?id=931653256fd24301a84fc77955914a82#!
eBird App	http://ebird.org/content/ebird/
Avian Knowledge Network	http://www.avianknowledge.net/
iNaturalist App	http://www.inaturalist.org/
Doodle	https://doodle.com/

CHAPTER 5 – Prepare for volunteers

MAIN TEXT	
Adventure Scientists	http://www.adventurescientists.org/
Volunteers & Service	https://www.fs.fed.us/working-with-us/volunteers/contact-us
Conservation Education	https://www.fs.usda.gov/conservationeducation
Volunteer.gov	https://www.volunteer.gov/
Forest Service Facebook	https://www.facebook.com/USForestService/
Forest Service Twitter	https://twitter.com/forestservice
Forest Service YouTube	https://www.youtube.com/user/usdaForestService
Forest Service blog	https://www.fs.fed.us/blogs
Citizen Science blog	https://www.fs.fed.us/working-with-us/citizen-science/stories
Forest Service Manual (FSM) 1800: Volunteers and Service	https://www.fs.fed.us/cgi-bin/Directives/get_dirs/fsm?1800
Volunteer Forms and documents are available on the Volunteers Share Point Site (Click on Volunteer Program Forms and download the zip file).	https://ems-team.usda.gov/sites/fs-rhvr-vsp/Pages/Enroll-Volunteers-(FSM-1830).aspx

Volunteer Service Agreement (301a)	https://www.fs.fed.us/sites/default/files/media/2015/13/fillable_OF301aVolunteerAgreement.pdf
Group Sign-up (301b)	https://www.fs.fed.us/sites/default/files/media/2015/13/fillable_OF301bVolunteerGroupSign-upForm.pdf
Volunteer Application	https://www.fs.fed.us/sites/default/files/media/2015/13/fillable_OF301VolunteerApplication.pdf
Photo Release	https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3814350.pdf
RELATED LINKS	
Build a Community – Federal Citizen Science Toolkit	https://crowdsourcing-toolkit.sites.usa.gov/step-3-build-a-community/
The Midewin National Tallgrass Prairie volunteer site	https://www.fs.usda.gov/main/midewin/workingtogether/volunteering
Negotiated Terms of Service Agreements	https://www.digitalgov.gov/resources/negotiated-terms-of-service-agreements/
Grants and Agreements: Roles, Tools, Process & Selecting Your Partnership.	https://www.nationalforests.org/assets/pdfs/Grants-and-Agreements-Roles-Tools-Process-Selecting-Your-Partnership.pdf

CHAPTER 6 – Develop your project evaluation

MAIN TEXT	
Broadening Participation in Biological Monitoring: Handbook for Scientists and Managers	https://www.fs.fed.us/pnw/pubs/pnw_gtr680.pdf

CHAPTER 7 – Share your results

MAIN TEXT	
The NatureWatch, Interpretation and Conservation Education database (NICE)	https://apps.fs.usda.gov/nice/f/welcome

Treesearch	https://www.fs.usda.gov/treesearch/search?keywords=citizen+science&authorlname=&title=&yearfrom=&yearto=&station=&series=&volume
Natural Resource Manager (NRM)	https://www.fs.fed.us/nrm/index.shtml
Enterprise Data Warehouse (EDW)	https://data.fs.usda.gov/geodata/edw/index.php
Data.gov	https://www.data.gov/
Geospatial Platform	https://www.geoplatform.gov/
Esri Story Maps	https://storymaps.arcgis.com/en/
Citizen Science Association	http://citizenscience.org/association/
Federal Projects Catalog	https://ccsinventory.wilsoncenter.org/
FSCCS webinars and sessions	https://www.fs.fed.us/working-with-us/citizen-science/resources
FSCCS mailing list	http://www.eepurl.com/c5H8db
CitSci Day	http://citizenscience.org/events/citizen-science-day/
Forest Service Facebook	https://www.facebook.com/USForestService/
Forest Service Twitter	https://twitter.com/forestservice
Forest Service YouTube	https://www.youtube.com/user/usdaForestService
Forest Service Instagram	https://www.instagram.com/u.s.forestservice/
Forest Service Flickr	https://www.flickr.com/photos/usforestservice/
Tongass National Forest Facebook	https://www.facebook.com/TongassNF
Tongass National Forest Twitter	https://twitter.com/TongassNF
Tongass National Forest Flickr	https://www.flickr.com/photos/36970379@N06/
Trout Unlimited Facebook	https://www.facebook.com/TroutUnlimited
Trout Unlimited Twitter	https://twitter.com/TroutUnlimited

Forest Service Citizen Science Blog	https://www.fs.fed.us/working-with-us/citizen-science/stories
Forest Service Blog	https://www.fs.fed.us/blogs
Federal CitSci Blog	https://www.citizenscience.gov/blog/
Flickr	https://www.flickr.com/
RELATED LINKS	
USFS General Technical Report, *Broadening Participation in Biological Monitoring: Handbook for Scientists and Managers*	https://www.fs.fed.us/pnw/pubs/pnw_gtr680.pdf
User's Guide to Evaluation Learning Outcomes for Citizen Science from the Cornell Lab of Ornithology *(note: this publication is largely focused on citizen science projects where participant learning is a primary focus, but still may be useful to projects with other objectives)*	http://sdchildrenandnature.org/wp/wp-content/uploads/2013/05/CornellLab_CitSci_UsersGuide_Evaluation_58p_2014.pdf

WORKS CITED

Armitage, D., Berkes, F., Dale, A., Kocho-Schellenberg, E., and E. Patton. 2011. Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. Global Environmental Change 21:995-1004.

Berkes, F. 2009. Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. Journal of Environmental Management 90:1692-1702.

C. McKinley, Duncan & Miller-Rushing, Abraham & Ballard, Heidi & Bonney, Rick & Brown, Hutch & Evans, Daniel & A. French, Rebecca & K. Parrish, Julia & Phillips, Tina & Ryan, Sean & Shanley, Lea & Lynn Shirk, Jennifer & F. Stepenuck, Krisitine & F. Weltzin, Jake & Wiggins, Andrea & D. Boyle, Owen & Briggs, Russell & Chapin III, F Stuart & A. Hewitt, David & A. Soukup, Michael. (2016). Citizen science can improve conservation science, natural resource management, and environmental protection. Biological Conservation.

Conrad, C.C., Hilchey, K.G., 2011. A review of citizen science and community-based environ-mental monitoring: issues and opportunities. Environ. Monit. Assess. 176, 273–291.

Bäckstrand, K. 2003. Civic science for sustainability: Reframing the role of experts, policy makers and citizens in environmental governance. Global Environmental Politics 3:24-41

Dickinson, J.L., Zuckerberg, B., and D.N. Bonter. 2010. Citizen science as an ecological research tool: Challenges and benefits. Annual Review of Ecology and Systematics 41:149-172.

Danielsen, F., Burgess, N.D., Balmford, A., 2005a. Monitoring matters: examining the potential of locally-based approaches. Biodivers. Conserv. 14, 2507–2542.

Danielsen, F., Jensen, A.E., Alviola, P.A., Balete, D.S., Mendoza, M., Tagtag, A., Custodio, C., Enghoff, M., 2005b. Does monitoring matter? A quantitative assessment of management decisions from locally-based monitoring of protected areas. Biodivers. Conserv.14, 2633–2652.

Gray, S., Jordan, R., Crall, A., Newman, G., Hmelo-Silver, C., Huang, J., Novak, W.,Mellor, D., Frensley, T., Prysby, M., Singer, A., 2016. Combining participatory modelling and citizen science to support volunteer conservation action. Biol. Conserv. (Citizen Science Special Issue).

Long, Jonathan W.; Ballard, Heidi L.; Fisher, Larry A.; Belsky, Jill M. 2016. Questions that won't go away in participatory research. Society & Natural Resources. 29(2): 250-263. https://www.fs.usda.gov/treesearch/pubs/48579

Kindon, S., Pain, R., and M. Kesby, eds. 2007. Participatory action research approaches and methods: Connecting people, participation and place. Routledge, New York, New York, U.S. 260 pp.

Krasny, M.E., and K.G. Tidball. 2012. Civic ecology: A pathway for Earth Stewardshop in cities. Frontiers in Ecology and the Environment 10:267-273.

McKinley, D.C., Briggs, R.D., and A.M. Bartuska. 2012. When peer-reviewed publications are not enough! Delivering science for natural resource management. Forest Policy and Economics 21:1-11.

Minkler, M., and N. Wallerstein. 2008. Community-based participatory research for health: From process to outcomes, 2nd ed. Jossey-Bass. 544 pp.

Shirk, J.L., Ballard, H.L., Wilderman, C.C., Phillips, T., Wiggins, A., Jordan, R., McCallie, E., Minarchek, M., Lewenstein, B.V., Krasny, M.E., Bonney, R., 2012. Public participation in scientific research: a framework for deliberate design. Ecol. Soc. 17.

Sullivan, B.L., Wood, C.L., Iliff, M.J., Bonney, R.E., Fink, D., Kelling, S., 2009. eBird: a citizenbased bird observation network in the biological sciences. Biol. Conserv. 142, 2282–2292.

Sullivan, P.J., Acheson, J.M., Angermeier, P.L., Faast, T., Flemma, J., Jones, C.M., Knudsen,E.E., Minello, T.J., Secor, D.H., Wunderlich, R., Zanetell, B.A., 2006. Defining and implementing - best available science for fisheries and environmental science, policy, and management. Fisheries 31, 460–465.